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ABSTRACT

The Summer Institute in Science was developed to address the need for updated information and training in physics, chemistry, and technology among elementary and secondary teachers. Three major objectives addressed were to: (1) improve teachers' understanding of basic concepts in the subject field; (2) provide teachers with training in the use of the essential elements to teach basic concepts in the subject field(s) of study; and (3) update teachers knowledge in their subject field(s) of study. The report includes a description of the operation of the project and an evaluation of its effectiveness. Sixty-seven teachers enrolled in the summer program. Courses were offered in earth science, general science, life science, chemistry, and physics. Evidence indicated that the program was successful in meeting its objectives. (MVL)

SUMMER INSTITUTE IN SCIENCE

A Category I Summer Inservice Program for
Elementary and Secondary Teachers of Science in the
State of Texas

Final Performance Report

Prepared by

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Submitted to the

Coordinating Board of the
Texas College and University System

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INTRODUCTION

The past three years are best described as a period of research, recommendation, and reform regarding precollege education. More than 200 local, state, and national task forces have studied the schooling process and issued reports decrying the state of precollege education. Particularly hard hit have been precollege programs in science and mathematics. That achievement in these subjects has undergone a sharp decline in the past 20 years has been well documented at the local, state, and national levels. Although the complexity of the problem is widely acknowledged, the finger of blame has come to rest frequently on the declining quality of teachers. Academically talented teachers are seldom attracted to teaching, the reports show, and those who do become teachers are among the first to leave the profession. Moreover, studies have shown that too many elementary and secondary students study too little science. This finding has led many states to increase the requirements in science for high school graduation. Increased graduation requirements along with more stringent course expectations for students have exacerbated the problem of the declining quality of science teachers.

The crisis in science education in Texas mirrors that of the nation. In its report titled Study of the Availability of Teachers for Texas Public Schools (1984), the Texas Education Agency documented the extent of the teacher supply/demand crisis in secondary science education. For several years teachers certified to teach science have been among the greatest in demand yet shortest in supply. The applications to openings ratio for science teachers at the beginning of the 1983-84 school year was next to the lowest, exceeded only by mathematics. The shortage of applicants to fill teaching vacancies in science in the 1983-84 school year resulted in the hiring of 1 out of 5 teachers who were less than qualified to teach science.

Schools and school districts have been placed in a bind. Increased course and graduation requirements in science necessitate the hiring of more and better qualified science teachers. Unable to find qualified or certified science teachers some school districts have resorted to "making do in the classroom". In a report titled "Making Do in the Classroom: A Report on the Misassignment of Teachers"(1985), the Council for Basic Education and the American Federation of Teachers provided state by state documentation to show that assigning teachers to teach subjects for which they have little academic preparation is completely legal. Faced with the task of offering more sections of existing science courses, school districts have exercised their legal authority and assigned teachers to teach science who have limited academic preparation in the subject. Unfortunately, only a few states maintain records to document the extent to which teachers are misassigned.

Out-of-field teaching can and does occur in Texas. A school district need only issue an Emergency Permit (<12 semester hours preparation) or a Temporary Classroom Assignment Permit (≥12 semester hours preparation) to any certified teacher. No records are maintained by the Texas Education Agency as to the extent to which the misassignment of teachers occurs.

The Summer Institute in Science was developed to address the need for updated information and training in science education among teachers of science throughout the State of Texas, particularly less than qualified teachers. The program was funded by the Coordinating Board of the Texas College and University System for the Spring, Summer, and month of September, 1986. The project was conducted at the Science Education Center, University of Texas at Austin. Total expenditures for the project amounted to $57,379, 25% below the projected budget total of $76,619 approved by the Coordinating Board. Three major objectives were addressed by the project:

1. To improve teachers' understanding of basic concepts in the subject field,

2. To provide teachers with training in the use of the essential elements to teach basic concepts in the subject field(s) of study, and
3. To update teachers' knowledge of recent developments and applications of knowledge in their subject field(s) of study.

The following sections of the report include a description of the operation of the Summer Institute in Science project and an evaluation of the project's effectiveness.

PROJECT OPERATION

The operation of the Summer Institute in Science project is described in the following sections, which adhere the approximate timeline for the project.

Planning and Recruiting

During the months of January through April, 1986, program plans were finalized and a recruitment strategy put into operation. Textbooks, laboratory equipment, and supplies were ordered. Guest speakers were identified for the noonday seminar series titled "Frontiers in Science". Room assignments and course schedules were completed. A working agreement was secured with Tom's Tabooley to offer a low cost daily menu from which participants could select lunch, which would be picked up and delivered at noon each day to the Science Education Center. In addition, Tom's Tabooley agreed to provide lunch, free of charge, to each guest speaker participating in the "Frontiers in Science" seminars.

Brochures were developed and a mailing list prepared (A copy of the brochure describing the Summer Institute in Science Program is included in Appendix A). Initially 1300 brochures were printed. One brochure was mailed to the superintendent of each of the 1100 school districts in Texas and to the science coordinator in each of the 20 regional Education Service Centers. Multiple copies of the brochure were mailed to science coordinators in several Texas school districts. Later, an additional 500 brochures were prepared. Brochures were mailed to five school districts designated by the Texas Education Agency as "underrepresented and underserved" Underrepresented and underserved includes districts falling in any two of the following three categories: (1) at least 50% minority, (2) at least 50% free/reduced lunch, and (3) wealth in the bottom 30% of school districts in Texas. Five underrepresented and underserved districts were identified as offering zero sections of lower level science: La Villa, Mcfaddin, Mumford, Westhoff, and Wingate ISD's. In addition, a follow-up telephone call was made to the superintendent in each of the five ISD's to announce the arrival of the brochures and to encourage the superintendent to pass along copies of the brochures to any teacher of science who might be interested in attending the Summer Institute in Science program.

Participant Selection and Notification

Persons interested in participating in the Summer Institute in Science completed an application form included with the brochure and returned it to the Project Director. A total of 94 application forms were completed and returned. During the last week of April participants were selected. The following criteria were used to select participants.

1. Applicants holding non-science certification assigned to teach in one or more fields of science.
2. Applicants holding science certification in a field of science different from the field(s) of science that they were assigned to teach.
3. Applicants teaching in "underrepresented and underserved" school districts.
4. Applicants on whose behalf a letter had been written by a school or district official in support of the applicant's participation in the Summer Institute in Science Program and

granting permission for the applicant to lead a workshop for other science teachers in the district at the start of the school year, 1986.

Acceptance letters were mailed to 73 applicants, along with a University registration form. In addition, housing request forms were mailed to 46 applicants, priority being given to persons whose home district was located the greatest distance from Austin and who had requested to enroll in morning and afternoon classes. Applicants not returning the registration and/or housing forms within two weeks were telephoned to determine whether they were still interested in attending the Summer Institute in Science. Persons declining to attend were deleted from the roster of participants and additional applicants invited. Unclaimed housing vacancies were offered to the next person on the waiting list.

Participant Characteristics

A total of 67 teachers attended the Summer Institute in Science. Tuition, fees, textbooks, and supplies were paid for the 67 teachers attending the Institute using funds provided by the EESA, Title II grant awarded by the Coordinating Board. Of the 67 participants, 40 teachers received housing and meals from Jester Center, located on the UT-Austin campus, using funds provided by the grant. Participants represented all but two of the regional education service centers in Texas; no teachers from regions 5 and 11 attended the Summer Institute in Science. Region 13 had the greatest number of teachers representing it with a total of 24 participants. The grade levels represented by the teachers attending the Summer Institute in Science were as follows: grades K-5, 16; grades 6-8, 30; and grades 9-12, 21. Table 1 shows the distribution of teachers attending the Summer Institute in Science by region service center and grade level.

Table 1
Distribution of Participants by Education Service Center

	Region ESC																				
Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
K-5	0	0	0	1	0	0	0	0	0	1	0	0	12	0	0	0	0	2	0	0	16
6-8	3	0	1	0	0	1	1	0	1	0	0	5	8	2	3	1	0	0	2	2	30
9-12	0	1	2	0	0	2	1	1	0	0	0	2	4	0	0	0	2	5	0	1	21
Total	3	1	3	1	0	3	2	1	1	1	0	7	24	2	3	1	2	7	2	3	67

To reduce the cost of operating the Summer Institute in Science program, participants were encouraged to enroll in two courses, rather than one. Tuition and fees for one course amounted to $113.50 and $165.20 for 2 courses. The cost per participant per course was reduced from $113.50 to $82.60 by enrolling in 2 courses. Of the 67 participants, 49 registered for 2 courses, and 18 registered for 1 course. Enrollment was greatest in the Earth Science course (n = 26) and least in the General Science course (n = 21). Teachers of science in grades K-5 were enrolled mostly in General Science (n = 13), with some enrolling in Earth Science (n = 5) and in Life Science (n = 3). Teachers in grades 6-8 were enrolled in all courses, however the greatest number of these teachers were enrolled in Earth Science (n = 19) and Life Science (n = 16). High school science teachers were enrolled in all courses except General Science, with the greatest number enrolled in the Chemistry (n = 19) and Physics (n = 17). The General Science course was offered for graduate credit in education (EDC 384P, Institute in Instruction: General Science), and the remaining courses were offered for advanced, undergraduate science credit (SCI 360, Institute in Science). Table 2 contains enrollment data by grade level for the five courses offered in the Summer Institute in Science.

Reasons	Gen. Sci	Life Sci.	Earth Sci	Physics	Chemistry	Average
Degree Requirements	14.7	4.9	4.3	3.9	2.0	5.4
Certification Requirements	2.9	7.3	6.4	17.6	13.7	10.3
Science Endorsement	8.8	7.3	6.4	5.9	7.8	7.1
Interest in Subjects	41.2	46.3	42.6	29.4	35.3	38.4
Career Ladder Credit	11.8	17.1	19.1	13.7	15.7	15.6
Other	20.6	17.1	21.3	29.4	25.5	23.2

Only a few teachers had ever participated in an extended inservice program designed specifically for teachers of science. Prior to the Summer Institute less than 1 out of 4 teachers reported that they had ever attended a summer or academic year institute designed for science teachers. The greatest percentage of teachers who had attended a teacher institute were teachers enrolled in the Earth Science course (34.6%), followed by teachers in Life Science (31.8%) and teachers in General Science (19.0%). Few teachers enrolled in the Chemistry (17.4%) or the Physics (16.7%) courses had ever attended at teacher institute. Teachers enrolled in the General Science, Life Science, or Earth Science courses reported recent attendance at a teacher institute (2.2, 5.0, and 4.0 years ago respectively). In contrast, it has been 8.0 years since teachers in either the Physics or Chemistry courses had attended a summer or academic year institute designed specifically for teachers of science. Past participants in an institute enrolled in the General Science, Life Science, and Earth Science courses reported receiving financial support to attend a prior teacher institute; only one teacher in the Physics or Chemistry courses had received financial support. Table 5 contains data on participants' record of attendance at a science teacher institute prior to attending the Summer Institute in Science

Table 5
Prior Attendance at a Teacher Institute

	Courses				
Attendance	Gen. Sci.	Life Sci.	Earth Sci.	Physics	Chemistry
No	19	16	15	17	20
Yes	5	7	9	4	4
Last Attended (yrs.)					
Range	1-5	1-16	2-9	1-18	1-17
Average	2.2	5.0	4.0	8.0	8.0
Financial Support					
No	1	0	2	3	3
Yes	4	5	4	1	0
No Response	0	2	3	0	1

Teachers expressed many needs prior to attending the Summer Institute in Science Regardless of the course in which they were enrolled, teachers reported that they would like but receive little or no assistance in their district in learning new teaching methods, acquiring instructional materials, implementing discovery/inquiry teaching methods, and obtaining information about technical applications of science. Most teachers enrolled in the Life Science, Earth Science, or Physics courses would also like but receive little or no assistance with subject matter information and using hands-on materials in the classes they teach. Teachers in the Life Science, Physics, or Chemistry courses would like information about science careers Maintaining live animals and plants is a need expressed by teachers enrolled in the General

Science course. Table 6 contains information about the needs of the teachers prior to attending the Summer Institute in Science.

Table 6
Needs of Teachers Prior to Attending Summer Institute in Science

	Courses														
	Gen. Sci.			Life Sci.			Earth Sci.			Physics			Chemistry		
Need\Need level	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Estab. Instruct. Object.	16	4	1	10	10	2	12	12	2	13	9	2	9	7	7
Planning Lessons	13	7	1	12	8	2	16	9	1	17	6	1	18	3	2
New Teaching Methods	4	14	3	1	13	8	2	20	4	2	18	4	6	12	5
Teaching Lessons	14	5	2	13	7	2	13	10	3	15	6	3	17	4	2
Developing Tests	15	3	3	11	9	2	15	9	2	11	10	3	13	9	1
Instructional Materials	4	13	4	1	15	6	6	16	4	3	13	8	3	10	10
Subject Information	8	8	5	2	15	5	6	18	2	6	12	6	9	6	8
Discovery/Inquiry	8	10	3	4	12	6	6	17	3	5	15	4	5	13	5
Hands-on Materials	8	8	5	6	10	6	9	12	5	9	12	3	9	6	8
Science Career Info.	11	7	3	4	14	4	13	10	3	8	14	2	9	10	4
Tech. Appl. of Science	7	11	3	4	13	5	6	17	3	8	14	2	5	12	6
Equipment/Materials	6	13	2	8	9	5	10	12	4	10	10	4	8	7	8
Maintaining Equipment	12	6	3	11	5	6	18	5	3	11	10	3	11	5	7
Small Group Work	17	2	2	13	6	3	16	7	3	17	3	4	13	5	5
Discipline	18	2	1	14	4	4	23	2	1	19	3	2	19	3	1
Coord. Across Grades	13	4	4	12	7	3	13	10	3	16	6	2	15	6	2
Maint. Animals & Plants	7	11	3	12	6	4	18	7	1	17	5	2	17	4	2

Note: 1 = Usually do not need assistance
2 = Would like assistance but receive little or none
3 = Would like assistance and receive adequate assistance

Program Operation

The Summer Institute in Science Program began with a Welcoming Banquet, held in the College of Education on Sunday evening, June 8, 1986, from 4:00 - 6:30 pm. Participants registered, obtained name tags, and had a few minutes to get to know one another. At 4:30 pm participants were welcomed by the Project Director, Dr. Frank E. Crawley, and introduced to faculty and staff. Dr. James P. Barufaldi, Director of the Science Education Center was introduced to Institute participants, after which he welcomed the group to the University and the Science Education Center. A short address titled "Excellence and its Flip Side" was then given by the Project Director. Participants were next given a brief overview of the characteristics of the teachers attending the Summer Institute in Science, an overview of the day-to-day operation of the program, and information concerning parking. Brief meetings were held with each of the five course instructors during which time participants were told about the course and given a course outline and textbooks. Teachers were also taken on a tour of the Science Education Center and shown the rooms in which they would be meeting for each course. Following the tour

participants, instructors, and project staff were treated to a catered dinner consisting of Texas barbecue with all the trimmings provided by Reese's Barbecue.

Classes met daily for three weeks, June 9-27, 1986. General Science, Life Science, and Physics courses were held Monday through Friday from 8:30 to 11:30 am. Earth Science and Chemistry courses met in the afternoon, 1:30 to 4:30, for the three weeks. The time from 11:30 am to 1:30 pm was reserved for lunch and the "Frontiers in Science" program, which consisted of a series of noonday seminars presented by faculty in the College of Natural Sciences.

Several formal and informal activities were offered during the noonday hour from 12:00-1:00 pm. Five presentations were made to participants by Faculty in the College of Natural Sciences, UT-Austin. The purpose of these presentations was to update teachers' knowledge of recent developments and applications of knowledge in their subject field(s) of study. Titled "Frontiers in Science", the noonday presentations included the following sessions:

Wednesday, June 11	Frontiers in Science—Geology Dr. Robert E. Boyer, Dean College of Natural Sciences
Thursday, June 12	Frontiers in Science—Computer Science Dr. Benjamin J. Kuipers Department of Computer Sciences
Monday, June 16	Frontiers in Science—Physics Dr. Austin M. Gleeson Department of Physics
Wednesday, June 18	Frontiers in Science—Biology Dr. Matthew M. Winkler Department of Zoology
Tuesday, June 24	Frontiers in Science—Chemistry Dr. Alan Campion Department of Chemistry

Six informal sessions were held during the noon hour and included the following:

Tuesday, June 17	Weird Tee Shirt Contest Judged by Dr. Lowell J. Bethel Assistant Dean for Teacher Education
Thursday, June 19	Evaluating Science Software Dr George Culp Director, Computation Center
Monday, June 23	Journals & Professional Organizations for Science Teachers Mr Glen Harral Graduate Student, Science Education, UT-Austin
Wednesday, June 25	Graduate Programs in Science Education Dr. James P. Barufaldi, Director, Science Education Center Dr. Frank E. Crawley, Graduate Adviser, Science Education
Thursday, June 26	Option 1—Tour of Dr. Winkler's Laboratory, Sea Urchin Research Conducted by Dr. Matthew Winkler

Option 2—Tour of the Tokomak facility, Department of Physics
Conducted by Dr. Austin Gleeson

During the three week program the Research Assistant, Mr. George F. Spiegel, designed and produced a logo to use on a T-shirt for Summer Institute in Science participants. A sample T-shirt was prepared and put on display in the Science Education Center office. Approximately 100 orders were taken for T-shirts, at a cost of $5.25 each. T-shirts arrived and were distributed to teachers on Thursday, June 26. It was agreed at this time that all participants, instructors, and staff would wear Summer Institute in Science T-shirts to the Closing Banquet.

On Friday, June 27, the Closing Banquet was held for participants in the Summer Institute in Science. The noonday banquet consisted of a soup, salad, and sandwich buffet catered by Tom's Tabooley. Ms. Nan Broussard, EESA Higher Education Program Director, was the guest speaker. Ms Broussard's presentation focused on the need for improved science instruction in Texas' public schools and the important role and responsibility teachers attending the Summer Institute in Science had in the overall improvement of science instruction. Upon completion of Ms. Broussard's presentation the Project Director made several closing comments, presentations, and announcements. Participants were reminded about the Teacher Workshops they had planned, prepared for, and were to present at the beginning of the Fall, 1986 semester to other teachers of science in their home district. In addition, teachers were reminded of the Science Hotline, a toll free number, which was available for their use during the month of September to talk with their course instructor about any problems they encountered with the content and investigations covered in the Summer Institute courses. The helpful assistance of course instructors and project staff was recognized and applauded. At the conclusion of the Closing Banquet, teachers were given a Certificate of Program Completion (designed by Mr. George F. Spiegel) and an Advanced Academic Training certificate issued by the Texas Education Agency.

PROJECT EVALUATION

During the last class meeting in each course participants completed five instruments designed to quantify the success of the Program. These instruments included the following:

1. Content Posttest - A test given in each course at the beginning and end of the Institute to measure participants' gain in knowledge of the content of each course in which they were enrolled.
2. General Questionnaire - A questionnaire (2 pages, 6 items) developed to collect information about teachers' needs prior to attending the Summer Institute in Science and the extent to which their needs were met in each course.
3. Program Evaluation - A Likert-type instrument (1 page, 19 items) developed to measure participants' attitudes concerning the general operation and requirements of the Institute
4. Course/Instructor Evaluation - A modified version of the standard Course/Instructor Survey used throughout the University (1 page, 23 items) designed to provide instructors with information concerning the participants' evaluation of the course and the instructor
5. Activities and Investigations Questionnaire - A questionnaire (6 pages, 42 items) developed to measure the extent to which participants intended to use the activities and investigations produced in the courses in which they were enrolled, their attitude toward use of the instructional materials, and the social pressures on teachers to use the materials.

The resulting data collected using each of these instruments is presented in the following sections (A copy of each instrument, except the content tests, is included in the Appendix) The final section addresses the question of project effectiveness, i.e., the extent to which the Summer Institute in Science accomplished its objectives.

Knowledge Gain

Instructors developed and administered a content test at the beginning and end of the course. Test questions were developed from course objectives. Instructors were free to develop any type of test, as long as the test questions were representative of the content and objectives of the course.

Most teachers entered the Summer Institute in Science lacking background training or courses in the subjects they studied. Pretest scores were lowest for participants enrolled in the Physics course, followed by those persons enrolled in the Earth Science, Life Science, General Science, and Chemistry courses. The content knowledge of participants increased significantly ($p \leq .05$) in all courses except General Science. Although content knowledge increased from pre- to posttest, teachers enrolled in the Earth Science and Physics courses recorded considerable variation their knowledge and understanding of the content at the end of these courses. Table 7 contains the descriptive statistics and results of a correlated sample t test of the significance of the difference in teachers' pre/post knowledge of the content of the course in which they were enrolled.

Table 7
Tests of Teachers' Content Knowledge

		M		SD			
Course	n	Pre	Post	Pre	Post	t	p
General Science	21	62.67	66.86	11.24	7.43	1.72	.0977
Life Science	22	58.00	82.18	16.04	9.46	9.40	.0000
Earth Science	26	55.39	71.92	12.80	18.44	4.91	.0001
Physics	24	54.17	76.17	14.20	15.36	11.60	.0000
Chemistry	23	76.83	89.00	15.26	6.62	4.70	.0002

Note. Maximum score range 0 to 100.

Teachers' Needs

Teachers entered the Summer Institute in Science with many instruction-related needs. Among the most frequently mentioned, teachers indicated that they would like but receive little or no assistance in their district in learning new teaching methods, acquiring instructional materials, implementing discovery/inquiry teaching methods, and obtaining information about technical applications of science.

At the end of each of the five courses participants were asked to indicate on a General Questionnaire which needs were adequately met by their instructor(s) in the Summer Institute in Science. More participants than not in the General Science and Earth Science courses indicated that all needs were adequately met by their instructors. Discipline was the only need not adequately met by the instructor of the Life Science course, according to the teachers enrolled. Teachers enrolled in the Physics course indicated in addition to their need for information on discipline that adequate attention was not given to their need for information on developing tests. Persons enrolled in the Chemistry course indicated that adequate attention was not given to developing tests and maintaining equipment. Table 8 contains data on the extent to which teachers' needs were adequately met by their instructor.

Table 8
Instructors Attention to Needs of Participants

	Courses									
	Gen. Sci		Life Sci.		Earth Sci.		Physics		Chemistry	
Need\Attention	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Estab. Instruct. Object.	13	0	13	1	18	0	16	3	17	1
Planning Lessons	16	0	12	1	17	0	12	6	9	4
New Teaching Methods	20	0	18	1	24	0	16	5	18	2
Teaching Lessons	15	1	13	0	19	0	11	8	9	5
Developing Tests	12	3	9	4	15	3	9	11	8	10
Instructional Materials	20	0	19	1	22	0	17	2	16	3
Subject Information	17	0	18	1	21	1	20	1	20	0
Discovery/Inquiry	17	0	16	2	23	1	15	5	11	4
Hands-on Materials	18	0	20	0	23	1	17	2	20	0
Science Career Info.	13	2	13	5	16	5	11	5	10	6
Tech. Appl. of Science	16	0	15	2	18	3	15	4	19	0
Equipment/Materials	15	1	14	2	20	1	16	3	13	3
Maintaining Equipment	8	3	8	5	10	5	9	7	7	8
Small Group Work	12	0	11	3	17	1	11	3	10	2
Discipline	10	3	5	7	9	6	7	7	7	6
Coord. Across Grades	13	1	17	2	17	2	10	4	10	4
Maint. Animals & Plants	20	0	16	2	16	2	6	3	6	6

Note. Not all participants responded to all items, and some participants indicated a need was and was not adequately met.

Program Evaluation

Participants were asked to indicate their feelings about returning to college and to evaluate specific features of the Summer Institute in Science. Generally speaking, elementary teachers were less anxious about returning to college than their secondary counterparts. Participants were uncertain as to the success of the Welcoming Banquet. The duration of the Institute and the time spent in class each day were acceptable to participants. Noonday seminars presented by faculty in the College of Natural Sciences were thought to be informative and stimulating. The informal noonday seminars were thought to be interesting, according to participants. Teachers tended to strongly agree that the resource guides would be useful to them when teaching the following school year and that the textbooks and materials were well chosen for each course. Teacher-conducted workshops are an effective means for sharing activities and investigations with other teachers, according to teachers. There was strong agreement among teachers that they would use the course materials, activities, and investigations when teaching the following year. There also tended to be agreement among teachers that the Science Hotline would be useful. There tended to be strong agreement among participants that the Summer Institute in Science Program was well organized and that members of the staff were helpful. Teachers agreed that the Institute accomplished its three goals:

1. to improve teachers' understanding of basic concepts in the subject field,
2. to train teachers in the use of the essential elements to teach science, and

3. to provide teachers with information about recent developments in science.

Overall, teachers agreed that the Summer Institute in Science was a success, that they would encourage teachers to apply for future Institutes, and that they would like to be considered for future training programs held at the Science Education Center. Results of the program evaluation are found in Table 9.

Course/Instructor Evaluation

Participants in each course were asked to complete a Course/Instructor Evaluation, a modified version of the Course/Instructor Survey used by students throughout the University to evaluate courses and instructors. Only minor changes were made in the wording of items to be consistent with the nature of the courses offered in the Summer Institute in Science. On occasion an item was deleted when it was inappropriate for the five courses offered. Additional items were added to better address the purpose of the Institute courses.

Results of the Course/Instructor Evaluation were overwhelmingly favorable, although there were minor variations in opinion about courses and instructors. Participants thought that instructors were well prepared, class time was well spent, they were free to ask questions, the instructor was intellectually stimulating, and the instructor revealed enthusiasm for teaching the course. Instructions for the activities and investigations were adequate and the activities and investigations clarified concepts taught in the courses. Participants tended to agree, although some were less certain, that tests were clear and they adequately covered topics included in the course. All participants, regardless of the course, thought that the texts and references were appropriate. Class activities tended to be appropriate for most teachers' needs, but more so in General Science than in the other courses. According to participants, instructors in the courses seemed interested in making each person a better science teacher, and participants thought that they learned much information applicable to the teaching of science. Teachers indicated that they would probably be satisfied with the grade they received in the course and that they found the course to be interesting, enjoyed attending class, and would recommend the course to other teachers interested in a science course for teachers. Participants agreed that they would use the material covered in each course when they taught and that the course had increased their interest in teaching science. Less agreement was registered among participants regarding the pace of each course, which was quite appropriate in General Science and Earth Science but not as appropriate in the Life Science, Physics, and Chemistry courses. Generally speaking, the number of topics covered in each course was sufficient, although there were slight variations in opinion among participants in each course. The results of the Course/Instructor Evaluation are presented in Table 10

Table 9
Participants' Evaluation of Summer Institute in Science

Item\Course	GS	LS	ES	PHY	CHM
Before attending the Summer Institute in Science, I was anxious about going back to school.	2.20	3.18	3.00	3.60	3.32
I was anxious about attending a summer program held at UT-Austin.	2.10	3.37	3.00	3.79	3.82
The Welcoming Banquet helped to clarify Institute expectations, procedures, and requirements.	3.00	3.36	3.23	3.50	3.32
Three weeks is an appropriate length of time for the Institute.	4.10	3.45	3.65	3.50	3.50
Three hours is an acceptable length of time to be in class each day for each course.	4.30	4.05	4.23	4.13	4.09
The noonday seminars presented by faculty in the					

College of Natural Sciences were informative.	4.05	3.50	3.77	3.58	4.00
The noonday seminars presented by faculty in the College of Natural Sciences were stimulating.	3.85	3.50	3.62	3.54	3.45
The informal noonday seminars covered topics of interest to me.	3.80	3.55	3.38	3.50	3.77
The resource guides will be useful when teaching science next year.	4.50	4.77	4.73	4.58	4.77
The textbooks and materials used in each course were well chosen.	4.00	4.55	4.77	4.54	4.45
Teacher-conducted workshops are an effective means for spreading the work to other teachers about Institute activities/investigations.	4.40	4.45	4.58	4.21	4.32
I intend to use the course materials, activities, and investigations when teaching science next year.	4.65	4.77	4.73	4.46	4.64
The Science Hotline will be useful to me when I begin teaching next year.	3.85	4.14	4.15	3.58	3.68
The Summer Institute in Science Program was well organized.	4.60	4.45	4.27	4.25	4.36
Members of the Institute staff were helpful.	4.75	4.05	4.62	4.46	4.41
The Summer Institute in Science Program accomplished its goals:					
to improve teachers' understanding of basic concepts	4.65	4.45	4.54	4.08	4.18
to train teachers in the use of the essential elements	4.50	3.73	3.96	3.88	3.82
to provide teachers with information about recent developments in science.	4.50	4.45	4.31	4.17	4.05
Overall, the Summer Institute in Science was a success.	4.85	4.64	4.81	4.29	4.41
I will encourage teachers to apply for future Summer Institute in Science Programs.	4.70	4.64	4.58	4.17	4.23
I would like to be considered for future teacher training programs held at the Science Education Center.	4.70	4.64	4.85	4.29	4.41

Note: 1 = Strongly Disagree 2 = Disagree 3 = Uncertain 4 = Agree 5 = Strongly Agree

Table 10
Participants' Evaluation of Courses and Instructors

Item\Course	GS	LS	ES	PHY	CHM
The instructor was well prepared.	4.72	4.22	4.77	4.33	4.58
Class instruction was time well spent.	4.61	4.14	4.50	4.17	4.25
The instructor made me feel free to ask questions and express my ideas.	4.78	4.64	4.54	3.75	4.29
The instructor was intellectually stimulating.	4.61	4.68	4.69	4.42	4.25
The instructor revealed enthusiasm for teaching the course.	4.83	4.73	4.69	4.25	4.42
Investigations and discussions clarified concepts for me.	4.28	4.55	4.35	4.04	4.21
The instructor gave adequate instructions for activities, investigations, and assignments.	4.28	4.05	4.35	3.96	4.13
Test questions were clear.	3.06	3.91	4.00	3.17	2.79
Tests adequately covered topics included in the course.	2.94	4.36	4.00	3.17	3.25

The texts and references used in the course were appropriate.	4.44	4.59	4.62	4.46	4.42
Class activities were appropriate to my needs.	4.72	3.82	4.42	3.96	4.08
The instructor seemed interested in making me a better science teacher.	4.78	4.55	4.81	4.08	4.46
I learned much material applicable to teaching science.	4.39	4.59	4.54	4.29	4.38
I will probably be satisfied with my grade in this course.	3.61	4.09	4.15	3.88	4.04
I found this course to be interesting.	4.78	4.41	4.65	4.54	4.54
I enjoyed attending class.	4.78	4.32	4.77	4.08	4.46
I will recommend this course to other teachers interested in a science course for teachers.	4.78	4.73	4.62	4.08	4.33
I will use the material covered in this course when I teach science.	4.86	4.73	4.58	4.33	4.63
This course has increased my interest in teaching science.	4.86	4.45	4.69	4.08	4.13
The pace of the course was about right.	4.28	3.18	4.19	3.13	2.46
The number of topics covered was sufficient.	4.22	3.91	4.19	3.63	3.50

Note: 1 = Strongly Disagree 2 = Disagree 3 = Uncertain 4 = Agree 5 = Strongly Agree

Activities and Investigations Questionnaire

One of the major outcomes of the Summer Institute in Science was to provide teachers attending the program with activities and investigations covering the content of the course in which they were enrolled. Each of the activities and investigations stressed the development of one or more science concepts through active use of the essential elements. Instructors provided teachers enrolled in their course with written materials suitable for use with students they would be teaching at the start of the new school year. These materials stressed the purpose, equipment, essential elements, and procedures to be followed for an activity/investigation and contained summary and extension questions. Although it would be impossible to visit teachers' classrooms during the following school year to see the activities in use, information was sought regarding teachers' intention to use the activities and investigations with students during the new school year. Social psychology offers a theory for linking intention and behavior.

The Theory of Reasoned Action was developed by social psychologists to better understand and predict human behavior. The theory was developed by Ajzen and Fishbein (1975) and has been found to be extremely successful in explaining such diverse human behaviors as drinking, dieting, choosing a career, planning a family, voting, and purchasing a product (1980). In education, the Theory of Reasoned Action has been used to gain information about the intent of grade 8 students to enroll in a high school science course (Coe, 1986). According to the theory, the best predictor of someone's behavior is the person's intention to perform the behavior. Intention to engage in a specific behavior has been shown to be determined by two variables, one personal and the other social. Attitude toward the behavior, the personal component, represents the extent to which a person believes that performing a behavior will lead to desirable consequences. Subjective norm, the social component, is a measure of the extent to which an individual believes that important "others" think the behavior should be performed. Intention, attitude, and subjective norm are the three variables, according to the Theory of Reasoned Action, needed to predict and understand behavior.

An Activities and Investigations Questionnaire was constructed following the method described by Ajzen and Fishbein (1980). During the last class meeting information was collected from

teachers in each course concerning their intention to use 50% of the activities and investigations completed in the Summer Institute in Science course with the students they would be teaching during the following school year. In addition, teachers completed items that assessed their attitude toward the behavior (i.e., using 50% of the activities and investigations completed in the Summer Institute in Science course with the students they would be teaching during the following school year). Teachers also indicated whether most people important to them thought they should perform the behavior (i.e., use 50% of the activities and investigations completed in the Summer Institute in Science course with the students they would be teaching during the following school year).

Intentions to perform the behavior, attitudes toward the behavior, and subjective norm data were obtained from each participant enrolled in each course [Note: Of the 57 participants 49 were enrolled in two courses]. Teachers' intentions to use the activities and investigations were quite similar, regardless of the course in which they were enrolled. The greatest variation in the group scores occurred on teachers' Attitude toward use of the activities and investigations. Scores ranged from 7.74 to 5.96 (possible score range = -9 to 9). Subjective norm, the extent to which teachers perceived pressures from people important to them to use the activities and investigations, were somewhat higher for teachers enrolled in the Life Science course. Table 11 contains descriptive data on intention, attitude, and subjective norm for participants enrolled in each of the five courses.

The means for the three outcomes (intention, attitude, and subjective norm) were analyzed separately for teachers enrolled in the five courses, using analysis of variance techniques. No differences were found in the intention and subjective norm scores attributable to the course in which teachers were enrolled. Teachers registered different attitudes toward using 50 % of the activities and investigations with the students they would teach during the following year, depending on the course. Follow-up tests revealed that teachers enrolled in Earth Science recorded less positive attitudes than did their counterparts enrolled in General Science or Life Science, and teachers enrolled in Physics recorded less positive attitudes than did teachers enrolled in Life Science. Table 12 contains the results of significance tests; Table 13 contains the results of follow-up tests for differences in attitude for teachers enrolled in the five courses

Table 11
Intention, Attitude, and Subjective Norm Data by Course

Outcome\Course	GS	LS	ES	PHY	CHM
Intention	2.65	2.67	2.32	2.50	2.52
Attitude	7.56	7.74	5.96	6.33	6.95
Subjective Norm	2.20	2.57	2.40	2.08	2.29

Note: Score range = -3 to 3 for intention and Subjective Norm and -9 to 9 for Attitude, in integer steps

Table 12
Results of Separate ANOVAs for Three Outcomes

Outcome	Effect	SS	df	MS	F	p
Intention	Course	1.80	4	0.45	0.51	.7332
	Error	93.89	106	0.89		
Attitude	Course	50.40	4	12.60	2.80	.0292
	Error	453.88	101	4.49		
Subjective Norm	Course	3 12	4	0.78	1.33	.2644
	Error	62.46	106	0.59		

Note: Five incomplete responses on Attitude outcome.

Table 13
Attitude Score Differences by Course

Course\Course	GS	LS	ES	PHY	CHM
GS		-0.19	1.59	1.22	0.60
LS			1.78	1.40	0.79
ES				-0.38	-0.99
PHY					-0.61
CHM					

Note: $p \leq .05$

According to the Theory of Reasoned Action, intention to perform a behavior is determined by attitude toward the behavior and subjective norm. Teachers' intention to use the activities and investigations with the students they would teach during the following school year is determined by teachers' attitudes toward use of the activities and investigations and their beliefs that persons important to them want them to do so. An intercorrelation matrix was computed for teachers enrolled in each of the five courses to determine the degree of association among the three outcomes—intention, attitude, and subjective norm.

Regardless of the class in which teachers were enrolled, their intention to use the activities and investigations was unrelated to what they perceived that people important to them wanted them to do. With the exception of the persons enrolled in Life Science, teachers' personal beliefs concerning the value of using the activities and investigations, their attitude, proved to be a significant predictor of intention. Personal beliefs, not the desires of other people, appear to be the best predictors of teachers' intention to use the activities and investigations with the students they will teach during the following school year. Table 14 contains data from teachers enrolled in each of the five courses summarizing the correlation between intention and attitude and intention and subjective norm.

Table 14
Outcome Intercorrelations by Course

Outcome Correlation\Course		GS	LS	ES	PHY	CHM	Total
Intention/Attitude	r	.68	-.08	.59	.46	.53	.54
	p	.0013	.7341	.0029	.0220	.0190	.0000
Intention/ Subjective Norm	r	-.12	.00	.29	.16	.20	.10
	p	.61	.9999	.1524	.4644	.3858	.2772

PROJECT EFFECTIVENESS

The Summer Institute in Science brought to the campus of the University of Texas at Austin 67 teachers of science from school districts located throughout the State of Texas. Participants represented 18 of the 20 regional education service centers. Although "interest in the subjects" was the primary reason cited by most teachers for attending the Summer Institute in Science, many indicated that they wanted to satisfy requirements for certification or endorsement to teach one or more science subjects. Both veteran teachers and recent recruits participated in the summer program. For three fourths of the teachers the Summer Institute in Science was the first summer or academic year institute designed specifically for teachers of science that they had ever attended.

Teachers entered the Summer Institute in Science with a variety of needs. They reported that they would like but receive little or no assistance in their district in learning new teaching methods, acquiring instructional materials, implementing discovery/inquiry teaching methods, and obtaining information about technical applications of science. Most of their needs were adequately met by the instructor for the course(s) in which they were enrolled. Moreover, teachers registered significant gains in their knowledge of science. The program, courses, and instructors received extremely favorable evaluations from the teachers attending the Summer Institute in Science.

Evidence indicates that the Summer Institute in Science was successful in meeting its objectives. The objectives of the program were:

1. To improve teachers' understanding of basic concepts in the subject field,
2. To provide teachers with training in the use of the essential elements to teach basic concepts in the subject field(s) of study, and
3. To update teachers' knowledge of recent developments and applications of knowledge in their subject field(s) of study.

Program evaluation data show that participants reported the Summer Institute in Science to have accomplished, in their opinion, each of its three objectives (see Table 9).

Content knowledge data reveal that all participants, with the exception of General Science teachers, significantly improved their understanding of the basic concepts in the subject field (Objective 1). Teachers enrolled in the General Science course, however, did show gains in understanding as a result of instruction. In addition, the variation in understanding of science which had existed among teachers enrolled in General Science at the start was considerably reduced by the end of the three week course.

Evidence indicates that teachers were trained in the use of the essential elements to teach basic concepts in the subject field(s) of study (Objective 2) and that the instructional materials developed for use in their classrooms will be used during the school year. Self report data

contained on the Program Evaluation completed by all participants show that teachers were provided with training in the use of the essential elements to teach basic concepts in the subject field(s) of study. Only 6 of 116 responses given by teachers indicated disagreement that the program had been successful in providing teachers with training in the use of the essential elements to teach science. Furthermore, 95% of the responses indicated teachers intended to make use of the activities and investigations, which utilize the essential elements, when teaching science. Only 2 of 111 respondents were opposed to using the instructional materials.

In the Frontiers in Science seminars Natural Science faculty presented information to update teachers' knowledge of recent developments and applications of knowledge in their subject field(s) of study (Objective 3). Presentations included the most recent developments and applications of knowledge in geology, chemistry, physics, biology, and computer science and stressed research presently being conducted by the guest scientist, as well as related research efforts taking place in other institutions. Nearly all teachers reported the seminars to be informative and stimulating (see Table 9); only 13% (29 of 228) of the responses were unfavorable.

The Summer Institute in Science proved to be a cost effective means of improving teachers' knowledge of science, training them in the use of the essential elements to teach science, and updating their knowledge of recent developments in science. Furthermore, the data overwhelming show that Summer Institute in Science training improved teachers' instructional skills and renewed their interest in teaching science. With more than 9 out of 10 teachers intent on using the activities and investigations with their students the Summer Institute in Science will have a pronounced positive impact on the quality of scien. teaching in science classrooms throughout the State of Texas.

Appendices

1. Summer Institute in Science Brochure
2. General Questionnaire
3. Program Evaluation
4. Course/Instructor Evaluation
5. Activities and Investigations Questionnaire

(Note: Copies of all questionnaires are available from the Project Director)